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A Review on Pharmacognostical and Pharmacological Activites of *Zingiber Officinale*

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Abstract:
Ginger is one of the important medicinal plants which naturally occur in various countries. Ginger; Zingiber officinale belongs to family Zingiberaceae. Young ginger rhizomes are juicy and fleshy with a very mild taste. They are often pickled in vinegar or just cooked as an ingredient in many dishes. They can also be steeped in boiling water to make ginger tea, to which honey is often added; sliced orange or lemon fruit may also be added. Ginger can also be made into candy or ginger wine which has been made commercially since 1740. Mature ginger rhizomes are fibrous and nearly dry. The juice from old ginger roots is extremely potent and is often used as a spice in Indian recipes, and is a quint essential ingredient of Chinese, Korean, Japanese and many South Asian cuisines for flavoring dishes such as seafood or goat meat and vegetarian cuisine. Ginger acts as a useful food preservative. Fresh ginger can be substituted for ground ginger at a ratio of 6 to 1, although the flavors of fresh and dried ginger are somewhat different. Powdered dry ginger root is typically used as a flavoring for recipes such as gingerbread, cookies, crackers, cakes, and ginger beer. Ginger produces a hot, fragrant kitchen spice.
Keywords: Ginger, *Zingiber officinale*, Medicinal plant, ginger rhizomes

1. Introduction

Ginger (Zingiber officinale) or ginger root is the rhizome of the plant Zingiber officinale, consumed as a delicacy, medicine or spice. It lends its name to its genus and family (Zingiberaceae). Other notable members of this plant family are turmeric, cardamom and galangal. The distantly related dicots in the Asarum genus have the common name wild ginger because of their similar taste [1]. Ginger is indigenous to southern China, from whence it is spread to the Spice Islands and other parts of Asia, and subsequently to West Africa and to the Caribbean [2]. Ginger (Zingiber officinale Roscopae) is a creeping perennial on a thick tuberous rhizome, which spreads underground. In the first year, a green, erect reed like stem about 60 cm high grows from this rhizome. The plant has narrow; lanceolate to linear-lanceolate, 15- 30 cm long leaves which die of each year. The odor and taste are characteristic, aromatic and pungent. Ginger, valued as a spice has been used through ages in almost all systems of medicine against many maladies. The plant is indigenous to Southeast Asia and is cultivated in a number of countries including India. The smell and taste of the drug are typical and aromatic. The medicinal part of the herb is dried roots. It is now recognized as a drug of choice for nausea and vomiting. It has also been found useful in pregnancy related morning sickness. In rheumatoid arthritis and osteoarthritis it is used as a natural pain reliever and an anti- inflammatory agent. It is also useful in curing ulcer and preventing heart attack and stroke. A number of active constituents and medicinal properties have been reported during the last decade. The present article provides a comprehensive account of important medicinal properties of this versatile herb. Ginger is known as Sunthi in Ayurveda and description of the plant appears in the old text like Charaka, Sushruta, Vagbhatta and Chakra-dutta[3]. The use of drug is mentioned in form of Trikatu, a famous Ayurvedic remedy for the treatment of digestive disorders. In Ashtanga Hridaya, the plant has been used in Rasna Spatak Quath (a decoction based on seven medicinal herbs and a traditional remedy for arthritis [4]. Pharmacologically, the drug in Ayurveda has been described as appetizer. It is also indicated in ointment form for local application in pains.

Fig.1: Ginger plant

Fig.2: Ginger rhizome

Table 1: Classification

Plant	Kingdom
Class	Angiosperms
Class	Monocots
Class	Commelinids
Order	Zingiberales
Family	Zingiberaceae
Genus	Zingiber
Species	Z.officinale

Table 2: Different varieties of Ginger

Country	**Varieties**
India	Varada, Mahima, Suruchi, Himachal, Karakkal, Shabarimala, Pink ginger, Jolpaiguri, Braised
China	China ginger

Nepal	Bhakthapur, Navalparasi
Japan	Kintoki
Nigeria	Juggigian
Jamaica	Jamaica
Pakistan	Pakistan
Oman	Oman
Brazil	Brazil

Table 3: Top 10 Ginger producing states in India:

S.no	State	Production (turnover)
1.	Assam	122307
2.	Gujarat	70646
3.	Karnataka	50054.3
4.	Arunachal pradesh	57000
5.	Meghalaya	62994
6.	Sikkim	52110
7.	Orissa	35000
8.	Mizoram	28390
9.	WestBengal	25000
10.	Uttarakhand	23440
11.	Kerala	21249
12.	Andhra Pradesh	1369
13.	Telangana	12729

2. Materials and Methods

Plant material:

Dried *Z. officinale* fruits were purchased from Local market Pasuparthi, Tirupathi, Andhra Pradesh. India, and were identified and authenticated by Dr.K.Madhava Chetty, Assistant Professor, Department of Botany, S V University, Tirupati.

Preparation of aqueous *Z. officinale* extract:

All plant materials were washed; shade dried and powdered, then extracted with water in a soxhlet apparatus for 72 hours. The solvent was removed under reduced pressure to give a dry extract, 5% yield w/w with respect to the crude material and stored at - 20°C till experiment was not started. The weighed amount of aqueous extract was suspended in 1% gum acacia in normal saline for pharmacological activity. This extract was used for phytochemical analysis for standardization.

Macroscopical studies:

The material of *Z. officinale* were subjected to macroscopical studies which comprised of organoleptic characteristics of the drug viz., size, colour, odour, taste, smell, texture, fracture etc.

Microscopical studies:

Qualitative microscopic evaluation was carried out by taking powder. 5 g of the drug sample was taken, powdered. The powdered material was taken on an 85mesh sieve and allowed in slow running water for washing away the minerals. The materials were cleared in chloral hydrate, wash with distilled water and mounted in glycerin and then observed characters. [5]

Chemical and nutritional components:

Various types of chemicals have been isolated from *Zingiber officinale* and extensively studied for their chemical structure by using advanced analytical techniques such as gas chromatography-mass spectroscopy (GC-MS) and high-performance liquid chromatography (HPLC). The fresh and dried *Z. officinale* extracts have been reported to possess gingerols, 1,7-bis-(40-Hydroxy-30-methoxyphenyl)-3,5-heptadione, adenine, 1- Dehydro-3-dihydro-gingerdione, Acetoxy-6-dihydroparadol, Isogingerol, 5-Methoxy-gingerol, Methyl diacetoxy-gingerdiol, Methyl diacetoxy-gingerdiol, 1-Dehydro-gingerdione, Acetoxy-gingerol, Shogaol, Paradol, 1-(40 Hydroxy-30-methoxyphenyl)- 7-octen-3-one, 1-(40-Hydroxy-30-methoxyphenyl)-7-decen-3-one, 1-(40-Hydroxy-30- methoxyphenyl)-7-dodecen-3-one, beta-sitosterol palmitate, isovanillin, glycol monopalmitate, hexacosanoic acid 2,3-dihydroxypropyl ester, maleimide-5- oxime, p-hydroxybenzaldehyde, 1-(omega-ferulyloxyceratyl) glycerol's [6]. Fresh ginger contains 80.9% moisture, 2.3% protein, 0.9% fat, 1.2% minerals, 2.4% fibre and 12.3% carbohydrates. The minerals present in ginger are iron, calcium and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C. The composition varies with the type, variety, agronomic conditions, curing methods, drying and storage conditions Ginger is used widely in a variety of food because of its nutritional composition and flavouring compounds. Fresh ginger is reported to contains protein, fat, minerals, fibers, carbohydrates, lipids (including glycerides, phosphatidic acid, lecithins, and fatty acids), protease, iron, calcium, magnesium, potassium, and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C [7, 8].

Table 4: Observed values for various parameters of zingiber officinale

S. No.	Parameters studied	Observed values (%w/w)
1	Foregin matter	1.24
2	Loss on drying	11.2
3	Total ash	07.30
4	Acid insoluble ash	0.82
5	Alcohol soluble extract	9.45
6	Water soluble extract	24.21

Table 5: Preliminary Phytochemical analysis of extracts of Zingiber officinale

S.No.	Test for	Chloroform extract	Aqueous extract	Ethanolic extract
1.	Alkaloids	-	-	-
2.	Glycosides	-	+	+
3.	Flavanoids	-	-	-
4.	Sterols	+	-	-
5.	Triterpenoids	+	+	+
6.	Saponins	-	+	+
7.	Tanins	-	+	+
8.	Carbohydrates	-	+	+
9.	Proteins	-	+	+
10.	Amino acids	-	+	+
11.	Volatile oils	-	-	-

Chemistry:

In the fresh ginger rhizome, the gingerols were identified as the major active components and gingerol [5-hydroxy-1-(4-hydroxy-3-methoxy phenyl) decan-3-one is the most abundant constituent in the gingerol series. The powdered rhizome contains 3-6% fatty oil, 9% protein, 60-70% carbohydrates, 3-8% crude fiber, about 8% ash, 9-12% water and 2-3% volatile oil. The volatile oil consists of mainly mono and sesquiter–penes; camphene, beta-phellandrene, curcumene, cineole, geranyl acetate, terphineol, terpenes, borneol, geraniol, limonene, linalool, alpha-zingiberene (30-70%), beta-sesquiphellandrene (15-20%), beta-bisabolene (10- 15%) and alpha-farmesene. In dried ginger powder, shogaol a dehydrated product of gingerol, is a predominant pungent constituent upto biosynthesis3-5. Oleoresin, which is isolated by acetone and ethanol extraction, contains 4-7.5% of dried powder, pungent substances namely gingerol, shogaol, zingerone and paradol. The oleoresin has also been found to contain zingiberol, the principal aroma contributing component as well as zingiberene, gingediol, diarylheptanoids, vitamins and phytosterols.

Biosynthesis:

Macleod and Whiting (1979) stressed the importance of dihydroferulic acid and hexanoic acid in the biosynthesis of (S)-6-GN in ginger [9]. The roles of these compounds were further elucidated when the complete route of biosynthesis of (S)-(+)-6-GN in ginger was proposed by Denniff and Whiting (1976a) and (Denniff *et al.*, 1980) [10, 11]. According to these researchers, phenylalanine is converted to dihydroferulic acid, which subsequently participates in a biological Claisen reaction with malonate and hexanoate to form 6- dehydrogingerdione, which is finally converted to 6-GN (Scheme 1). Ramirez-Ahumada *et al.*, 2006 suggested an alternative pathway for 6-GN biosynthesis in ginger, in which particular enzymes, including phenylalanine ammonia lyase, p-coumaroyl shikimate transferase, p-coumaroyl quinate transferase, caffeic acid O-methyltransferase and caffeoyl- CoA-O-methyltransferase, play key roles in the process[12].

Applications in Herbal Therapy:

- Against nausea and vomiting (antiemetic) during motion sickness.
- Apparently, this effect is not mediated through the central nervous system (CNS), but rather, ginger's active [13,14]
- Principles act directly on the gastrointestinal tract.[15]
- To reduce vomiting in patients treated with cytotoxic compounds. [16,17]
- To promote digestion and as an antiflatulent or carminative to reduce gas and bloating.[18]
- To improve blood circulation. [19]
- To lower blood glucose in the treatment of diabetes [20].
- To treat migraine headache.[21]
- As a sialagogue, to promote salivation.[22,23]

3. Pharmacology

Anti-cancer effects:

Anticancer effects of ginger are thought to be attributed to various constituents including vallinoids, viz. (6)-gingerol and (6)-paradol, shogaols, zingerone, and Galanals A and B.[24-25]Galanals A and B have been found to be potent apoptosis inducers of human T lymphoma Jurkat cells.[24]

Anticoagulant Effects

Ginger has been shown to inhibit platelet taggregation and to decrease platelet thromboxane production *in vitro* Gingerol, shogaol, (paradol, and gingerol analogues (1 and 5) exhibited antiplatelet activities. [25] However, its effects *in vivo* have not been well studied. Ginger to decrease platelet aggregation, no effect of ginger on platelet count, bleeding time, or platelet aggregation.[26] Similarly, ginger to have no effect on platelet aggregation, fibrinolytic activity, or fibrinogen levels and no effect of oral ginger on platelet thromboxane B2 production. While thromboxane levels to be decreased by ginger ingestion in a small study [27].

Antiemetic Effects

The mechanism of action of ginger's effect on nausea and vomiting remains uncertain. However, there are several proposed mechanisms. The components in ginger that are responsible for the antiemetic effect are thought to be the gingerols, shogaols, and galanolactone, a diterpenoid of ginger.[28] Recent animal models and *in vitro* studies have demonstrated that ginger extract possesses antiserotoninergic and 5- HT3 receptor antagonism effects, which playan important role in the etiology of postoperative nausea and vomiting, In a randomized, place-controlled, crossover trial of 16 healthy volunteers, ginger (1g orally) had no effect on gastric emptying.[29] It appears unlikely that ginger's anti-emetic or antinausea effects are mediated through increased gastro duodenal motility or through increased gastric emptying. Using gastro duodenal manometry, oral ginger increases antral motility during phase III of the migrating motor complex (MMC) and increases motor response to a test meal in the corpus [30].41 However, ginger had no significant effect in the antrum or corpus during other phases, except for a significant decrease in the amplitude of antral contractions during phase II of the MMC. Additionally, there was no effect of ginger on duodenal contractions or on the motility index.

Anti-Inflammatory Effects:

Ginger has a long history of use as an anti-inflammatory and many of its constituents have been identified as having anti-inflammatory properties.[31] Ginger has been found to inhibit prostaglandin biosynthesis and interfere with the inflammatory cascade and the vanilloid nociceptor12. Ginger has been shown to share pharmacological properties with non-steroidal anti-inflammatory drugs (NSAIDs) because it suppresses prostaglandin synthesis through the inhibition of cyclooxygenase-1 and cyclooxygenase-2. However, ginger can be distinguished from NSAIDs based on its ability to suppress leukotriene biosynthesis by inhibiting 5 lipoxygenase. [32] This discovery preceded the observation that dual inhibitors of cyclooxygenase and 5-lipoxygenase may have a better therapeutic profile and have fewer side effects than NSAIDs. It was also discovered that a ginger extract derived from *Zingiber officinale* (and *Alpina galanga*) inhibits the induction of several genes involved in the inflammatory response, including genes encoding cytokines, chemokines, and the inducible enzyme cyclooxygenase-2. This discovery provided the first evidence that ginger modulates biochemical pathways activated in chronic inflammation. Identification of the molecular targets of individual ginger constituents provides an opportunity to optimize and standardize ginger products with respect to their effects on specific biomarkers of inflammation.

Antinociceptive Effects

(6)-shogaol has produced anti-nociception and inhibited the release of substance P in rats, seemingly via the same receptor to which capsaicin binds. However, it was observed to be 100 times less potent and to elicit half the maximal effect of capsaicin. [33]

Antioxidant Effects

In vitro, ginger has been shown to exhibit antioxidant effects.15 (6)-gingerol appears to be the antioxidant constituent present in ginger, as it was shown to protect HL-60 cells from oxidative stress. [34] Ginger oil has dominative protective effects on DNA damage induced by H_2O_2. Ginger oil might act as a scavenger of oxygen radical and might be used as an antioxidant.

Cardiovascular Effects

In vitro research indicates that gingerols and the related shogaols exhibit cardio depressant activity at low doses and cardiotonic properties at higher doses.7 both (6)-shogaol and (6) - gingerol, and the gingerdiones, are reportedly potent

enzymatic inhibitors of prostaglandin, thromboxane, and leukotriene biosynthesis. [35]

Gastrointestinal Effects

There is evidence that ginger rhizome (root) increases stomach acid production. If so, it may interfere with antacids, sucralfate, H_2 antagonists, or proton pump inhibitors. In contrast, other *in vitro* and animal studies have revealed gastro protectiveproperties.16, 17 in addition, (6) shogaol, generally more potent than (6)-gingerol, has inhibited intestinal motility in intravenous preparations and facilitated gastrointestinal motility in oral preparations [36]. Ginger extract has also been reported to inhibit the growth of *Helicobacter pylori in-vitro*.5 However, Desai et al. observed a significant increase in the exfoliation of gastric surface epithelial cells following the consumption of 6g or more of ginger.[37]

Antitussive Effects

Shogaol, generally more potent than gingerol, has exhibited antitussive effects[38].

Immunomodulatory Effects

In vitro evidence indicates that ginger has immunomodulatory effects and is an effective antimicrobial and antiviral agent. [39]

Lipid Effects:

Buccal ingestion of ginger extract has been shown to have hypocholesterolemic, hypolipidemic, antiatherosclerotic effects in cholesterol-fed rabbits and in rats. Inhibition of LDL oxidation and attenuated development of atherosclerosis has also been observed in Apo lipoprotein E-deficient mice [40].

Weight Loss Effects: Spiced foods or herbal drinks, such as those that contain ginger, have the potential to produce significant effects on metabolic targets, such as satiety, thermogenesis, and fat oxidation [40]. A significant clinical outcome sometime may appear straight forwardly but also depends too strongly on full compliance of subjects. [41Thermogenic ingredients, such as ginger, may be considered as functional agents that could help restore a "positive energy balance" and prevent obesity.

Antiarthritic Effect

A study investigated the antiarthritic effects of ginger and its bioactive constituents. A wellcharacterized crude ginger extract was compared with a fraction containing gingerol and their derivatives to inhibit joint swelling in an animal model of rheumatoid arthritis, streptococcal cell wall-induced arthritis. Both extracts demonstrated anti-inflammatory activity. The crude dichloromethane extract, containing essential oils and more polar compounds, was more efficacious, when normalized to gingerol content, in preventing, both joint inflammation and destruction. [42] Non-gingerol components enhance the antiarthritic effects of the more widely studied gingerol

Antimicrobial Activities

Ingenol and [–shogaol, isolated from ginger rhizome, demonstrated antiviral activity.32 [10]-gingerol has been reported as active inhibitor of *M. avium* and *M. tuberculosis in vitro.* Gingerol and related compounds have been investigated for antimicrobial activities. [6]- gingerol and [1-gingerol, isolated from ginger rhizome, demonstrated antibacterial activity against periodontal bacteria.[43]

Radio Protective Activity

In vitro, pre-treatment with [6]-gingerol reduced UVB-induced intracellular reactive oxygen species levels, activation of caspase- 3, -8, -9, and Fas expression. It also reduced UVB-induced expression and transactivation of COX-2. [44] Translocation of NF-κB from cytosol to nucleus in HaCaT cells was inhibited by [6] - gingerol via suppression of IκBα phosphorylation (ser-32). Examination by EMSAs and immunohistochemistry showed that topical application of [6]-gingerol (30 μM) prior to UVB irradiation (5 kJ/m2) of hairless mice, also inhibited the induction of COX-2mRNA and protein, as well as NF-Kb translocation [45].

Antigenotoxic Activity:

Norethandrolone and oxandrolone were investigated for their genotoxic effect on human lymphocyte chromosomes using chromosomal aberrations and sister chromatid exchanges as parameters and subsequently Genistein and [6]-gingerol were used as antigenotoxic agents to ameliorate the genotoxicity induced by the steroids [46]. Norethandrolone and oxandrolone were studied at 5, 10, 20, 30 and 40 μM, respectively and were found to be significantlygenotoxic at 30 and 40 μM. Genistein and [6] - gingerol proved to be equally effective in reducing genotoxic damage at appropriate doses. [47]

4. Conclusion

Zingiber officinale (rhizome) is used as a medicine and also used in various types of Ayurvedic formulations. It shows various types of pharmacological activities such as anticancer, antiemetic, anticoagulant, antitussive, cardiovascular etc. It is easily available and more beneficial for human health. Commonly it is used in tea for the treatment of throat infection in villages and cities. It is used daily in spices and its nutritional value shows more important properties with this plant. This article has outlined some of the current thinking with regard to the experimental advances in gingerol and analogues. So far, reveals the empirical use of ginger in several ayurvedic medicinal products.

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